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Water Resource Management and Sustainability in Chhatrapati Sambhajinagar District, Maharashtra

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Abstract:

Chhatrapati Sambhajinagar District, the administrative centre of Maharashtra's Marathwada region, has long faced a serious and worsening water crisis. The district receives an average annual rainfall of only 734 mm, yet supports a population of over 3.7 million people who depend heavily on the Godavari river system, reservoirs and groundwater for all daily needs. This paper examines the current state of water resources in the district, identifies where management has fallen short and discusses practical steps toward long-term water security. Issues of groundwater depletion, reservoir siltation, surface water pollution, inequitable access and institutional fragmentation are analysed. The paper also evaluates ongoing interventions including watershed development, micro-irrigation, rainwater harvesting and participatory governance. It connects these challenges and responses to the Sustainable Development Goal 6 framework and reflects on the contribution that higher education institutions can make in promoting water sustainability. The paper draws on recent government reports, peer-reviewed research and field-level data.

Keywords: water resource management, Chhatrapati Sambhajinagar, Marathwada, groundwater depletion, Godavari basin, SDG 6, rainwater harvesting,

1. Introduction:

Water is at the centre of life in Marathwada, yet the region has been struggling with water scarcity for decades. Chhatrapati Sambhajinagar District, the administrative headquarters of Marathwada and formerly known as Aurangabad until its renaming in 2023 to honour the Maratha king Chhatrapati Sambhaji Maharaj, is a district where rivers flow through the landscape but drinking water still arrives by tanker in hundreds of villages every summer. As of April 2024, the district had the highest number of water tankers operating in all of Marathwada, with 443 tankers serving villages whose wells and groundwater sources had dried up months earlier (Down To Earth, 2024).

The district covers 10,100 square kilometres and had a population of approximately 3.7 million as per the 2011 Census. It lies between 19 and 20 degrees North Latitude and 74 to 76 degrees East Longitude and is drained primarily by the Godavari River and its tributaries. Average annual rainfall is only 734 mm, well below the state average, and its distribution across the year and across the district is highly uneven. Water storage in the ground is naturally difficult in the Deccan Trap due to the semi-arid climate and hard basalt geology. Not only geography is the worse part of the crisis. It comprises of poor management, poor coordination of governance, poor irrigation methods and increasing urban pressures that have stretched the water system of the district to its edge (Chhatrapati Sambhajinagar District Administration, n.d.).

Maharashtra, despite having the highest number of large dams in India at over 2,117 as of 2023, continues to have one of the lowest proportions of irrigated agricultural land relative to its sown area. Jayakwadi Dam

in Paithan taluka, the largest earthen dam in Asia and the primary source of drinking water for the city of Chhatrapati Sambhajinagar, illustrates this paradox. It was built to irrigate more than 1.8 lakh hectares but farmers in its command area report that canals have silted over and water rarely reaches them (IndiaSpend, 2024). On top of this, upstream districts have historically diverted water before it can reach Jayakwadi, leading to persistent inter-district water conflicts (Down To Earth, 2024).

This paper looks at the water resource crisis in the district from a management and sustainability perspective. It draws on recent research, government reports and field-level evidence to map out what is going wrong and what can be done about it. The contribution of institutions of higher learning is addressed in particular with regard to the theme of this National Seminar on Higher Education and Sustainable Development. The paper also contextualizes the water issues in the district in the Sustainable Development Goal 6 context that aims at ensuring that all people have access to clean water and that water is managed sustainably by 2030 (United Nations Department of Economic and Social Affairs, 2024).

The hypothesis that the water crisis in Chhatrapati Sambhajinagar District is more a governance and management issue than a natural resource issue informs this paper and that specific solutions in irrigation efficiency, watershed development, institutional coordination and community participation can have a significant positive impact in reversing the trend of water depletion and inequitable access in the district.

2. Research Methodology:

This paper follows a descriptive and analytical research design. It is based entirely on secondary data, drawing from published government reports, peer-reviewed journal articles, field-level surveys conducted by independent organisations and official district-level records. The sources will be annual reports of the Central Ground Water Board, the data of the Maharashtra Water Resources Department, published research on the water systems of Marathwada, and results of the community water governance projects of the India Water Partnership in the district.

The methodology entails three processes. To start with, pertinent information regarding the availability of water, groundwater levels, water storage in the reservoirs, water quality, and irrigation methods was gathered in the recent literature published between 2019 and 2025. Second, this information was synthesised to determine water stress patterns, failure of management and successful intervention. Third, the results were aligned to the SDG 6 targets to determine existing gaps and areas to act on. The analysis also uses research concerning education to get the idea of how academic institutions can play a role in the water governance. There were no major fieldwork or survey data gathered in this study.

3. Geographical and Hydrological Profile:

3.1 Landscape and Geology:

The topography of Chhatrapati Sambhajinagar District is conditioned by the Deccan Trap basalt that is a hard volcanic rock and covers the majority of Marathwada. The geology is vital on the availability of water. Basalt is not water absorbent. The majority of the rainfall that falls is washed off the surface and not absorbed into the ground, which severely reduces ground water recharge. The lowlands of the district rise at an average level of 600 to 670 metres above sea level. Notable hill ranges include Antur at 826 metres, Abbasgad at 671 metres and Ajintha at 578 metres. Total forest area covers only 135.75 square kilometres, which is around 9.03 percent of the district relative to Maharashtra's forests. Low vegetation cover means the soil has little protection from runoff during monsoon rains (Chhatrapati Sambhajinagar District Administration, n.d.).

Hard rock aquifer zones of exactly this type are found across Maharashtra, and recent sustainability research notes that the fragility of such aquifers is compounded by urban expansion onto recharge areas and floodplains. Once these natural recharge zones are built over, the groundwater system loses its ability to replenish itself, no matter how much rain falls (Wescoat et al., 2022).

3.2 River Systems:

The Godavari is the principal river of the district and one of the major peninsular rivers of India. Its tributaries within and near the district include Purna, Shivna, Kham, Dudhna, Galhati and Girja. The Tapi River basin covers the north-western corner. During the monsoon these rivers carry substantial volumes of water. Beyond the monsoon most of them diminish greatly or become completely dry. Urban development has caused a severe degradation of the Kham River that passes through Chhatrapati Sambhajinagar city. The effluents of industries and unprocessed municipal wastewater release have transformed it into a seasonal, highly polluted drain. Its fundamental water quality indicators are well beyond the safe levels all year round. Such urban rivers as the Kham when neglected do not only fail as water sources but also prevent the recharge of groundwater in the urban catchment area (David, 2024).

3.3 Climate and Rainfall:

The climate of the district is semi-arid. The monsoon runs from June to September, winter from October to February and summer from March to May.

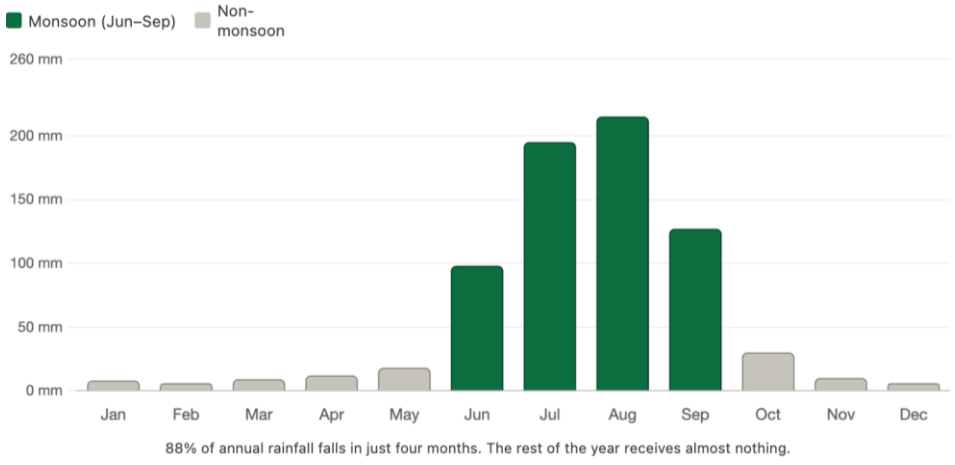

Figure 1. *Average monthly rainfall distribution in Chhatrapati Sambhajinagar District*

Figure 1 showing high seasonal concentration, with over 88% of annual rainfall occurring during the June to September monsoon window (Source: India Meteorological Department). Summer temperatures can reach up to 45.9 degrees Celsius while winter temperatures can fall as low as 5.6 degrees Celsius. The average annual rainfall of 734 mm is uneven across years and across the district, with eastern talukas generally receiving less than western ones. Recent climate research using Statistical Downscaling Model and Standardized Precipitation Index found that the district is increasingly vulnerable to drought under both RCP 4.5 and RCP 8.5 future climate scenarios, with projected temperature rises and more erratic monsoon patterns likely to increase water stress through evapotranspiration and reduced effective precipitation (Khalid et al., 2025).

4. Current State of Water Resources:

4.1 Surface Water and Reservoirs:

The most important source of drinking and irrigation water for the district is the Jayakwadi Dam at Paithan on the Godavari River. It serves drinking water and irrigation needs across five to eight districts of Marathwada and irrigates around 2.37 lakh hectares through its canal system. However, siltation has taken a serious toll. According to the results of the surveys, the dam had lost 31 percent of its dead storage capacity and 14 percent of its live storage capacity to siltation between 2003 and 2012 alone. Currently the dam is believed to have lost approximately 30 percent of its total capacity to siltation, which has a direct impact on the availability of water by year-end (Wikipedia, 2024). The dam was full to 100 percent four out of five years between 2019 and 2024, but still the district experienced water shortages during the same period,

which demonstrates that the issue is not only the volume of water that enters the dam but the distribution of the same afterward (Lokshahi English, 2024).

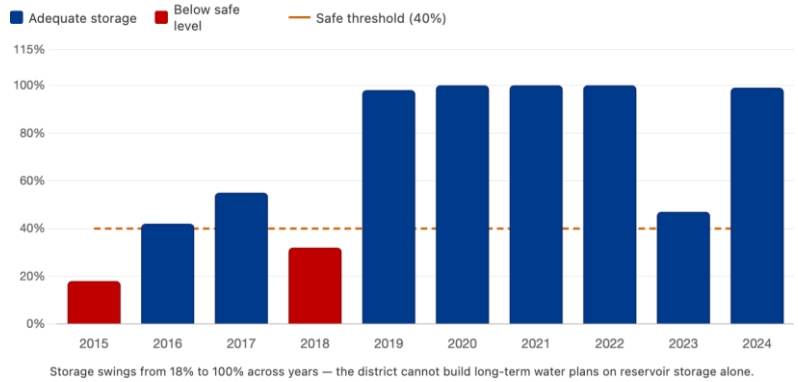

Figure 2. *End-of-monsoon storage levels at Jayakwadi Dam from 2015 to 2024*

Figure 2 illustrating extreme year-to-year variability and the risk of planning water security around reservoir storage alone (Source: Maharashtra Water Resources Department; Lokshahi English, 2024; Down To Earth, 2024). Other than Jayakwadi, records of Maharashtra Water Resources Department indicate that in 2024, major dams in the Chhatrapati Sambhajinagar region had stored only 19.38 percent water as compared to 40.79 percent in the same year the previous year. Medium dams were 17.78 percent and the small dams 14.52 percent (Down To Earth, 2024a). These figures bring out the fact that the annual change in storage is drastic and that water planning cannot be based on reservoirs.

4.2 Groundwater Depletion:

In rural locations, ground water forms the primary source of water to be used both in drinking and irrigation. Deccan Trap basalt limits the movement of groundwater to fractured and worn out areas. This causes the aquifer to be thin and weak. In the last thirty years, the farmers in the district have observed that the water tables have gone down to 300 metres or more as compared to the depth of 60 metres. The level of groundwater has dropped by approximately 245 metres in only 30 years in Beed and Jalna districts that border Chhatrapati Sambhajinagar (Down To Earth, 2024a). The Central Ground Water Board has declared a number of the talukas in the district to be over-exploited, i.e. the extraction in the talukas is already greater than the annual recharge. It has been confirmed that such a loss in the hard rock aquifer areas has a drastic impact on the sustainability of rural drinking water sources, which will require repeated drilling of boreholes and impose an additional financial load on already strained families (Wescoat et al., 2022).

Sugarcane farming is one of the principal causes of over-extraction of groundwater. In 2019 alone, the sugarcane planted in Marathwada required an estimated 6.15 billion cubic metres of water, which is almost half of the total water that is stored in the reservoirs of the region at the end of monsoon. The amount of water that sugarcane needs is approximately 2,500 mm annually, which is significantly above the average rainfall in the district, and is nearly completely irrigated with groundwater or canals (IndiaSpend, 2024). Even half of the sugarcane lands replaced with drip irrigation would conserve more water than Jayakwadi Dam capacity as per Maharashtra government presentation data used in research on the area.

4.3 Water Quality:

The water quality issues are experienced in both surface water and groundwater in the district. In case of surface water, the most apparent issue is the degradation of the Kham River. Directly it receives untreated sewage of large portions of the city. Pharmaceutical and textile plants located in the MIDC areas have also been reported to pollute water bodies located within the vicinity of the district (David, 2024). In the case of groundwater, fluoride is a major issue. According to the 2023 water quality assessment by the Central Ground Water Board, using 15,259 samples, 9.04 percent of the groundwater samples in the country had toxins in excess of the allowable levels of fluoride, and Maharashtra is one of the states with a high rate of

this issue. The chronic use of water with a high content of fluoride leads to dental and skeletal fluorosis, especially in children (Central Ground Water Board, 2020; Mongabay India, 2025). The second water quality issue in the district is nitrate contamination due to the extensive application of heavy fertilisers in agricultural lands. A specific study on the Aurangabad division ground water reported high nitrate and fluoride concentrations in areas associated with granite and volcanic parent rock in semi-arid conditions precisely the kind of environment that defines this district (Kadam et al., 2023).

5. Key Challenges in Water Management:

The water resource crisis in Chhatrapati Sambhajinagar is not the result of a single factor. It comes from several overlapping problems, some natural and many the result of decisions made over decades. The following points capture the main challenges.

- More than 75 percent of the total water consumed in the district is used in agriculture. Large volumes are wasted by flood irrigation which is still commonly used. Sugarcane planting occupies the irrigated land even though it consumes much more water than the rainfall that the area gets. Unless sugarcane is cultivated at present size with proper drip irrigation, the water shortage in the district will remain (Dingre, 2023).

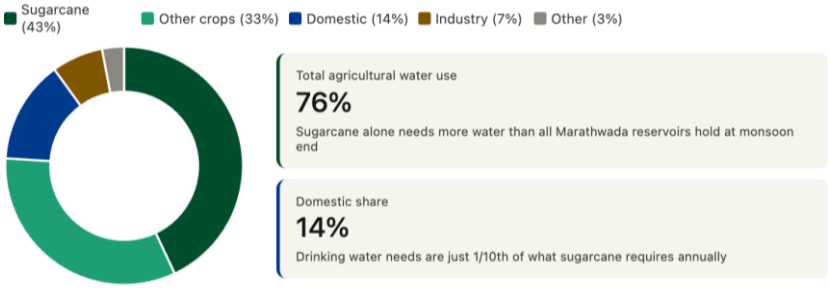

Figure 3. Estimated sector-wise water use in Chhatrapati Sambhajinagar District

Figure 3 showing agriculture's dominant share of approximately 76%, with sugarcane cultivation alone consuming a disproportionate volume relative to its area (Source: Government of Maharashtra, 2019; IndiaSpend, 2024).

- The district contains 10 talukas, 1,362 villages and a complicated system of government comprising of 867 gram panchayats and 9 panchayat samitis. Various agencies operate in discoordinated way in various sections of the water system. Maharashtra Water Resources Department, Maharashtra Jeevan Pradhikaran, Zilla Parishad and municipal corporations are independent of each other. This fragmentation causes delays, responsibility gaps and redundancy (Evaristo et al., 2023).
- The urbanisation has decreased the area of urban catchment to recharge natural groundwater. Due to the increase in the city of Chhatrapati Sambhajinagar, the surface concretisation has prevented the rainwater that seeps into the ground. It implies that urban groundwater that is already stressed is replenished less every year (David, 2024).
- Siltation of the reservoirs is being done without adequate desilting efforts. Areas of catchment have been invaded and vegetation cover diminished, enhancing the rate of silt inflow. This is slowly reducing the water storage capacity of dams every year (IndiaSpend, 2024).
- Access to water is not equal. The most unreliable supply is in marginalised communities and villages of remote talukas. In the under-served villages, women are the biggest burden in terms of water collection. It has been identified that water scarcity disproportionately impacts such households, and studies conducted throughout Maharashtra have indicated that Chhatrapati Sambhajinagar region has the largest amount of villages affected by water scarcity compared to other regions in the state (Shinde and Kulkarni, 2024).
- The flagship drought-proofing programme, the Jalyukt Shivar Abhiyan, initiated by the Maharashtra government in 2016, allocated close to 9,630 crore over a period of 10 years, produced

storage capacity to provide water to 487 individuals in one year, when compared to the normal per capita norms. This leads to the failure of even big investments that are not planned and executed with a long-term sustainability perspective (Down To Earth, 2024b).

6. What is Being Done: Sustainability Interventions:

6.1 Watershed Development:

The most common tool that is still used in enhancing water availability at the village level is watershed development. In 2021 alone, 1,891 works were undertaken in the district under MGNREGS that were related to water conservation, rainwater harvesting, renovation of water bodies, reuse and recharge structures, watershed development and afforestation (Down To Earth, 2024b). The dams, nala bunds, contour trenches and farm ponds constructed under these schemes have demonstrated quantifiable increases in the local groundwater levels and soil moisture in areas where well-constructed wells have been developed. The problem is that the maintenance post-construction is not budgeted or obligatory, and most of the structures become in bad condition after several years of being constructed.

The Marathwada Water Grid Project, which was announced by the Maharashtra Chief Minister Devendra Fadnavis with a cost of 20,000 crore is expected to link 11 dams in Marathwada by a 1,330 km pipeline network so as to lessen the reliance on the levels of individual reservoirs. Another idea in the project is to transport 55 TMC of water in the western rivers to the Godavari basin. When applied well, this may be a game changer on the water security of the region (Devgatha, 2025).

6.2 Rainwater Harvesting:

One of the least expensive ways of responding to water scarcity in the district is rainwater harvesting. Farm ponds have been encouraged at the community level through the Magel Tyala Shet Tale scheme of the state government that subsidises the construction of ponds in the fields of farmers at a rate of Rs. 75,000 or 70 to 75 percent. The monsoon runoff is trapped in farm ponds which enable farmers to have additional irrigation during dry seasons during and after the monsoon season instead of relying on groundwater borewells. Launched on a national level in 2019, the Jal Jeevan Mission includes such source sustainability measures as rainwater harvesting and groundwater recharge as mandatory elements of the programme (Ministry of Jal Shakti, 2019). The Chhatrapati Sambhajinagar Municipal Corporation in urban areas has made it mandatory to have rooftop rainwater harvesting in large buildings, but this has not been strictly followed.

6.3 Micro-Irrigation:

Drip and sprinkler irrigation under the Pradhan Mantri Krishi Sinchayee Yojana offer a direct way to reduce the agricultural water demand that drives the district's water crisis. Research on Maharashtra's drip irrigation programme found that water consumption for sugarcane, banana and cotton fell by 56.5, 60 and 46 percent respectively per hectare after adoption of drip systems compared to flood irrigation. Yields also improved: banana by 73 percent, sugarcane by 36 percent and cotton by 80 percent. The scheme provides subsidies of 55 percent for small and marginal farmers and 45 percent for others, up to five hectares (Narayanamoorthy et al., 2024). By 2021 to 2022, micro-irrigation had reached approximately 8.86 lakh hectares across Maharashtra, though the state still ranks among the highest users of groundwater per unit irrigated land, suggesting that adoption gains are being offset by rebound effects such as expansion into more water-intensive crops (Impacts of Micro-irrigation Technologies, 2023).

6.4 Jal Jeevan Mission:

The national Jal Jeevan Mission has been the most significant recent push for rural drinking water access in India. As of February 2025, the mission has connected over 15.44 crore rural households with functional tap connections, covering approximately 79.74 percent of India's rural households. Maharashtra's tap connection coverage reached around 71 percent under the programme by 2022, though the sustainability of these supply systems in hard rock aquifer districts like Chhatrapati Sambhajinagar remains a concern. Research finds that Maharashtra's mission implementation has focused heavily on capital expenditure for coverage and has given relatively less attention to the long-term sustainability of village water schemes

after handover (Wescoat et al., 2022). The programme has shown that community-led management works: in Maharashtra's Mhapan village, a women's self-help group took over management of the village tap scheme, achieved full bill collection and made the scheme financially self-sustaining (Ministry of Jal Shakti, 2025).

6.5 Community Water Governance:

Water management works best when the people who use the water are involved in governing it. Water User Associations for canal irrigation have been set up in several command areas of the district. Where they function well they improve equitable water distribution and reduce conflict. At the village level, Village Water Management Committees supported by civil society organisations have been piloted in Fulambri block of the district, where five villages in 2022 and 2023 organised youth-led water stewardship processes, pre-monsoon water level recording and scientific adaptation measures including aquifer assessment and groundwater recharge planning (India Water Partnership, 2023). These community-led governance models, when scaled up, are among the most effective and durable pathways to sustainable water management.

7. Water Management and SDG 6:

The United Nations Sustainable Development Goal 6 calls for universal access to clean water and sanitation by 2030, along with improvements in water quality, water use efficiency, integrated water resources management and protection of water-related ecosystems. As of 2023, global progress on integrated water resources management stood at only 57 percent, still far from the 2030 target of 91 percent (United Nations Department of Economic and Social Affairs, 2024). India's progress on SDG 6 has been assessed in multiple recent studies. Although the nation has gone a long way in the development of sanitation and water supply systems, there are still acute gaps in the quality of water, fair access and environmental safeguarding, especially in the semi-arid areas of Marathwada (Biswas et al., 2022; Sarkar and Bharat, 2021).In the case of Chhatrapati Sambhajinagar District, the SDG 6 goals by 2030 will not be achieved only through infrastructure. A study that looks at the obstacles and the impetuses of SDG 6 in India has found out that poor wastewater management, excessive extraction of ground water, climate change and institutional fragmentation are the major impediments to development. The same research suggests that the regional institutions should be strengthened, establishing climate-resilient infrastructure and, crucially to this seminar, incorporating water and sanitation in school and college curricula as a behaviour change gateway and improved governance results (Aman et al., 2025).

The interrelations between SDG 6 and other development goals are also important in this case. Water scarcity has implications on food security, health of people, gender equality and economic development. When women take hours a day to fetch water, they are deprived of time to get an education and earn income. Children who consume polluted groundwater experience health effects in the long run. The issue of water sustainability in the district is thus not a technical exercise but one that is related to the general human development objectives (Biswas et al., 2024).

8. The Role of Higher Education:

Colleges and universities within and around Chhatrapati Sambhajinagar are also placed to play a significant role in ensuring the sustainability of water. This is not just theoretical. Colleges of Marathwada have geography, environmental science and civil engineering departments that are near the communities that are the most hit by water stress. They are able to make contributions in a number of pragmatic ways.

The initial input is research and monitoring. At the district and taluka level, systematic local groundwater level survey, water quality, watershed status and sedimentation of the reservoir are required but not always available. This can be addressed by student research projects, faculty research and academic-government data-sharing alliances. The longitudinal record required in adaptive water management decisions could be constructed using data in community wells monitored by college students over several seasons, e.g. Studies

of drinking water sustainability in Maharashtra have repeatedly identified that the absence of data on the local level is one of the critical obstacles to the effective planning (Wescoat et al., 2022).

The second one is community education and outreach. The knowledge of the origin of water, i.e., a simple knowledge of how water is depleted and what conserves it is still low in most rural and peri-urban communities of the district, which is water literacy. This knowledge can be transferred to communities by college students in the form of extension activities, local-language workshops and school programmes. The research on SDG 6 has shown that educational interventions on water and sanitation have quantifiable behaviour and community governance change (Frontiers in Education, 2024).

The third contribution is transfer of technology. The design of farm ponds, low-cost water purification, rooftop rainwater harvesting and GIS-based watershed mapping can be transferred out of college laboratories into community practice by demonstration projects. College Geography and Environmental Science departments are in a good position to do this. Lastly, advocacy can be reinforced with the help of academic research. Policy demands of more equitable and sustainable water governance are supported by studies recording the gendered effect of water scarcity, the unfair allocation of water between the talukas and the health effects of ground water contamination. This National Seminar is a contribution in itself.

9. District Water Profile at a Glance:

Table 1: Key Water Resource Indicators for Chhatrapati Sambhajinagar District

Indicator	**Details**
Total District Area	10,100 Sq. km
Average Annual Rainfall	734 mm
Temperature Range	5.6 degrees C (min) to 45.9 degrees C (max)
Forest Cover	135.75 Sq. km
Major Rivers	Godavari, Tapi; tributaries: Purna, Shivna, Kham, Dudhna, Galhati, Girja
Primary Reservoir	Jayakwadi Dam (Paithan) -- largest earthen dam in Asia
Jayakwadi Siltation Loss	Approximately 30% of total capacity lost to silt
Groundwater Status	Several talukas classified over-exploited (CGWB)
Key Water Challenges	Tanker dependence, groundwater depletion, water quality, sugarcane water overuse
Key Government Schemes	Jal Jeevan Mission, PMKSY micro-irrigation, MGNREGS watershed works, Marathwada Water Grid

10. Conclusion:

Chhatrapati Sambhajinagar District has the rivers, the rainfall and the human capacity to manage water sustainably. What has lacked is the concerted effort, proper investment and sincere community participation. Water crisis in this case is not unavoidable. It is the outcome of decisions made/not made across decades and even improved decisions can alter the course. The way is evident. Unproductive flood

irrigation must be replaced with drip irrigation. Watershed structures must be constructed and not merely erected and left behind. Reservoirs are to be desilted. The sewage of rivers in the cities such as Kham should be taken care of. And governance must cease to be disjointed between agencies that are not even conversing. None of this is beyond reach. A number of villages in the district have already demonstrated that community-based water management can be effective whereby people are provided with ownership and encouragement. Jal Jeevan Mission has shown that when there is political goodwill and investment, rural access to water can be undertaken in large scale. Institutions of higher learning can actually contribute to this. One of the contributions that colleges can make today is research, community outreach and trained graduates who are knowledgeable about water sustainability. The aim of working together on the water security of the 3.7 million people in the district is worth pursuing.

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